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APPLICATION FOR LETTERS PATENT
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Be it known that we, John Beal, a citizen of the United States, residing at 1902 Edinburgh Terrace, Atlanta, Georgia 30307 U.S., and John Hotchkiss, a citizen of the United States, residing at 6510 Stapleford Lane, Duluth, Georgia 30097 U.S. have invented a

**REMOVABLE MATERIAL HOPPER ASSEMBLY AND METHOD OF USING SAME
TO ELIMINATE RESIDUAL INGREDIENT MATERIAL**

of which the following is a specification.

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REMOVABLE MATERIAL HOPPER ASSEMBLY AND METHOD OF USING SAME TO ELIMINATE RESIDUAL INGREDIENT MATERIAL

RELATED US APPLICATION DATA

This application claims priority from U.S. Provisional Application No. 60/268,590 filed 14 February 2001, incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a process and machinery for the plastics extrusion industry, particularly to a removable material hopper assembly for gravimetric blenders, and more particularly for gravimetric batch blenders. The hopper assembly is capable of releasably securing the hopper to a blender, the hopper for storing at least one particulate ingredient and delivering that particulate ingredient with high-precision metering for the blender to, for example, an extruder. A method of using the removable hopper assembly is also disclosed, during which no residual ingredient material is left on the blender after hopper removal.

2. Description of Related Art

Conventional blending devices blend various types of solid particulate ingredients, such as plastic pellets. These devices typically include a number of ingredient hoppers, each of which discharges ingredients into individual metering units. These metering units typically include a metering auger, the rotational speed of which can be varied to control the flow rate of the individual ingredients. The metering units typically discharge, or feed, individual ingredients into some sort of common hopper at independently controllable feed rates which can be varied to produce and control the desired blend of individual ingredients. A metering unit, particularly of a batch blender, may also consist of a gate mechanism, the opening time of which can be varied to control the amount of material fed of an individual ingredients.

One disadvantage of blenders, and in particular conventional batch blenders is difficulty in cleaning. Thorough cleaning of the hoppers is normally required to avoid contamination when changing ingredients, particularly when changing feed material having a different color than what was once held in the hopper. To simplify cleanout of the hoppers and related parts of the

blender, it is desirable to removably mount the hoppers so that they may be individually removed. To avoid spillage, each removable hopper should have a shut-off mechanism in the neck of the removable hopper to cut off the ingredient flow through the neck when, and after, the hopper is being removed.

Even without unintended spillage, the removable hopper should limit, and preferably eliminate, residual material being left over from the hopper removal process. Although not technically spilled out from the hopper during removal, material that remains behind on the blender below the shut-off mechanism in the neck of the hopper must nonetheless be separately cleaned away before hopper return.

One attempt at a removable hopper design is disclosed in U.S. Patent No. 6,057,514 to Maguire. This patent is directed to a gravimetric weigh scale blender with a hopper slidably supported on a frame. The hopper is removably mounted on the frame and horizontally slidably movable with the frame between a first and a second position. The hopper includes a discharge opening located substantially over a weigh pan when the hopper is at the first position.

A metering means, not attached to the hopper, comprising a pneumatic piston-cylinder actuated slide gate combination selectively releases material from the hopper into a mix chamber. A separate shoe is provided that is movable with respect to the hopper. The shoe is orientated above the metering means such that the shoe and slide gate are separated by a distance. The shoe comprises a valve opening in registry with the discharge opening in an open-valve condition, and out of registry with the discharge opening in a closed-valve condition. The shoe presents this valve between the hopper discharge opening and the mix chamber, wherein the shoe is removable with the hopper from the frame.

The blender further comprises a means for mounting the shoe on the hopper for displacement between the open-valve condition and the closed-valve condition, and an operator engaging the shoe for effecting such displacement. The operator is a saddle on the frame abutting the shoe for effecting shoe displacement relative to the hopper when the hopper is moved horizontally with respect to the frame. The saddle is responsive to a horizontal slidable movement of the hopper to position the shoe in the open-valve position when the hopper is at the first position operably mounted on the hopper frame, and to displace the shoe to the closed-valve

position when the hopper is slidably moved toward the second position and removed from the hopper frame.

Prior to the Maguire device, it was known to put a valve at the bottom of a hopper to control the amount of material being fed to the blender's metering means. It also was known to provide removable hoppers with slide gates, and it was known to use a shoe to prevent hopper material spill. More specifically, it was known to place a hopper on a sliding track for removal and to make the shoe on the bottom of the hopper close the bottom of the hopper and removable with the hopper.

What Maguire appears to have provided to the art is a removable hopper design incorporating a sliding gate and a separate removable shoe, wherein the removable shoe has a specific geometry limited to a bottom plate coplanar with the discharge opening of the hopper, the shoe further having upstanding vertical and inclined side flanges slidably engaging vertical and inclined side walls of the hopper, wherein a saddle on the frame is operable to displace the shoe in the plane of the discharge opening in a path parallel to parallel sides of the opening.

Thus, while the Maguire device provides a removable hopper, such removability is at the price of complexity of parts and difficulty in practice. The shoe and hopper are slidably movable in only a very unforgiving and limited way, laterally through the use of a pin residing in a longitudinal slot of the shoe to control the relative position of the shoe when the hopper is movable between hopper open and hopper closed positions.

Further, the Maguire device provides only a limited solution to the problems of hopper cleanout procedures. Although the Maguire hopper is removable, ingredient material remains on top of the slide gate as the shoe and slide gate are separated by a distance. This material remaining between the shoe and slide gate must be manually cleaned upon hopper separation.

In view of the above, it is apparent that there exists a need to provide a simplified assembly enabling removability of a hopper from a frame. Additionally, such a removable hopper should limit or eliminate the residual material that remains after the prior art material hopper is removed from the frame. It is to the provision of such a removable hopper assembly that the present invention is primarily directed.

SUMMARY OF THE INVENTION

Briefly described, in a preferred form, the present invention is an improvement over the conventional hopper/blender unit by providing a removable assembly enabling removability of the hopper from the blender. The removable assembly comprises a sealing device to seal off the neck of the hopper during hopper removal from the blender. The same sealing device is also the metering control, regulating material flow rate from the hopper.

As a unit, the invention provides an ingredient hopper that is removable from a blender, wherein the hopper has a metering slide gate that can be used to tightly seal off the bottom of the hopper during the removable operation. The present removable material hopper assembly includes the hopper, a metering assembly and a releasable securing assembly. The metering assembly comprises a metering gate locking pin, the metering slide gate and a metering cylinder. In effect, the metering slide gate both regulates material flow rate from the hopper, and ensures that no residual material will remain on the blender during hopper separation. The metering slide gate slidingly moves along metering gate support guides by the metering cylinder. The metering slide gate can be locked against movement by the metering gate locking pin.

Further, a releasable securing assembly is provided that simplifies removability through the use of a quick release pin and retaining brackets on the top plate of the blender. The releasable securing assembly further comprises a tongue and locking groove subassembly that cooperate to align and lock the hopper on the top plate. The quick release pin can be slidably engagable through the bottom portion of removable hopper and corresponding retaining brackets. The tongue extends from the bottom portion of the hopper and is slidably engagable within a corresponding locking groove of a divider plate of the top plate. Such a design is distinguished from the prior art in that present blenders with removable hoppers include a sealing element and a shoe, both elements separate from the hopper and the blender.

The present invention's novel use of the metering gate as the shut-off valve during hopper removal necessarily eliminates the prior art disadvantage of residual hopper material being left on top of the metering gate, which residual material must be cleaned before the hopper can be placed once again on the frame. If the residual material is not separately cleaned away, the residual material will be left to mix with any new and different ingredient placed in the hopper.

Further, the novel releasable securing assembly makes hopper removal quick and easy.

Thus, an object of the invention is to provide an improved hopper/blender assembly. Another object of the present invention is to provide an improved removable hopper that is easy to lock and unlock into operational position. Yet another object of the present invention is the provision of a method of hopper removal that eliminates residual material left upon hopper separation. These and other objects, features, and advantages of the present invention will be more apparent upon reading the following specification in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a removable hopper mounted upon a blender top plate according to a preferred embodiment of the present invention.

FIG. 2 is a front elevation of a blender having mounted thereupon a plurality of releasable hoppers as that shown in **FIG. 1** of the present invention.

FIG. 3 is a cross-sectional enlarged view of a front elevation of **FIG. 1** illustrating the metering gate of the removable hopper of **FIG. 1**.

FIG. 4 is a front elevation of **FIG. 1**.

FIG. 5 is a perspective, exploded view of the removable hopper and blender top plate of **FIG. 1**.

FIG. 6 is a side view of **FIG. 2**.

FIG. 7 is a perspective view of a removable hopper mounted upon a blender top plate according to another preferred embodiment of the present invention.

FIG. 8 is a front elevation of a blender having mounted thereupon a plurality of releasable hoppers as that shown in **FIG. 7** of the present invention.

FIG. 9 is a cross-sectional enlarged view of a front elevation of **FIG. 7** illustrating the metering gate of the removable hopper of **FIG. 7**.

FIG. 10 is a front elevation of **FIG. 7**.

FIG. 11 is a perspective, exploded view of the removable hopper and blender top plate of **FIG. 7**.

FIG. 12 is a side view of **FIG. 8**.

FIG. 13 is a perspective view of a removable hopper mounted upon a blender top plate according to another preferred embodiment of the present invention.

FIG. 14 is a front elevation of a blender having mounted thereupon a plurality of releasable hoppers as that shown in **FIG. 13** of the present invention.

FIG. 15 is a cross-sectional enlarged view of a front elevation of **FIG. 13** illustrating the metering gate of the removable hopper of **FIG. 13**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now in detail to the figures, wherein like reference numerals represent like parts throughout the several views, **FIG. 1** shows the present removable hopper **10** securely mounted on a top plate **12** of blender **B** shown generally in **FIG. 2**. Blender **B** can be a gravimetric blender used by the plastics industry. A conventional gravimetric blender is designed to meter one or more material ingredients (typically in the form of resin pellets) from one or more removable ingredient hoppers **10** in controlled ratios by weight (i.e., gravimetrically), and to deliver these ingredients to a chamber **46**, typically a mixing chamber where multiple material ingredients are being metered. The ingredients are then available from the mixing chamber **46** to a material processing machine (not shown), such as an extruder, for further processing.

The figures generally fall into two sets of similar figures, as such, detailed description of the present invention will include specific reference to a first set of drawings, although specific differences between the two sets will be expressly noted. A first set of drawings, **FIGS. 1-6**, show a first embodiment of the present invention utilizing a horizontally positioned slide. A second set of drawings, **FIGS. 7-12**, show a second embodiment of the present invention utilizing a horizontally positioned slide, and a blender having a fixed hopper. **FIGS. 13-15** illustrate yet another embodiment of the present invention utilizing a vertically positioned slide.

It will be understood that the figures are representative of the present removable hopper assembly, and the invention is not so limited to the model type or number of hoppers used in conjunction with a particular blender. It will be further understood that unless specifically described otherwise, references to elements of a figure of the first set is applicable to similar elements of the corresponding figure of the second set of drawings - references to **FIG. 1** (first set) generally relate to references of **FIG. 7** (second set), references to **FIG. 2** (first set) generally relate to references of **FIG. 8** (second set), and so on.

The present invention comprises a removable material hopper assembly that enables easy removal of the removable ingredient hopper **10** from the top plate **12**. The removable hoppers **10**

can be combined in machines also including fixed hoppers. For example, **FIG. 8** illustrates a fixed hopper **76** flanked by removable hoppers **10**. The present removable hopper assembly includes a hopper **10**, a metering assembly **14** and a releasable securing assembly **100**. The hopper **10** can be a storage bin having at its bottom an open neck, or material passageway **44** (**FIG. 3**), through which material ingredients stored in the hopper **10** can exit the hopper **10**.

As shown in **FIGS. 3** and **4**, the metering assembly **14** generally comprises a metering slide gate **22** and a metering cylinder **36**. The metering slide gate **22** can be operably aligned utilizing metering gate support guides **66**, slidably movable by the retraction and extension of the metering cylinder **36**. The metering cylinder **36** can be an air cylinder. In the embodiment of **FIGS 13-15**, the metering assembly **14** can further comprise metering gate locking pin **16**.

The slide gate **22** can be retracted by the metering cylinder **36**, opening the bottom of the material hopper **10**, including material passageway **44**, and enabling material ingredients in the hopper **10** to dispense, for example, into a weigh chamber **52** below (**FIG. 2**). Guides **66** can provide alignment and support for the slide gate **22**. To seal off the hopper **10**, the slide gate **22** can be extended by the metering cylinder **36** until the slide gate **22** closes against a front seal **32**. Material can be kept from dropping out of the back of the metering assembly **14** by a rear seal **34**.

If metering slide gate **22** is inclined off the horizontal (**FIGS. 13-15**), the metering assembly **14** can further comprise metering gate locking pin **16**. The metering slide gate **22** can be restrained from intended or accidental movement by the metering gate locking pin **16**. As shown specifically in **FIG. 15**, slide gate **22** includes a locking portion **23**. The locking portion **23** of slide gate **22** incorporates a hole therethrough that corresponds to the dimensions of the locking pin **16**. With the locking pin **16** stored in a metering gate locking pin storage hole **24**, the slide gate can be unrestrained from movement along guides **66**. When the slide gate **22** is in a closed position, wherein the material passageway is effectively closed to falling material by the compressive communication of the slide gate **22** with the front seal **32**, the locking portion **23** of the slide gate **22** is positioned such that the locking pin **16** can extended through the locking portion **23** of the slide gate **22** and restrain movement of the slide gate **22**. For example, the hopper **10** is shown with a restraining slot **25** that restrains the locking pin **16** and slide gate **22** from relative motion. Although metering gate locking pin **16** and associated elements can be

utilized with a metering slide gate **22** inclined off the horizontal, these elements may also be incorporated with hopper assemblies having a horizontally positioned gate **22**.

The present removable hopper assembly further comprises a releasable securing assembly **100**, which when working in relationship with the metering assembly **14**, enables the hopper **10** to be removed from the top plate **12** leaving minimal or no residual material requiring separate clean up. As shown in **FIG. 5**, the releasable securing assembly **100** can comprise a quick release pin **18**, hopper tongue **26**, divider plate **28**, locking grooves **42** and retaining brackets **68**. It will be understood that a combination of less than all of these elements, or all of these elements, may be used to releasably secure the hopper **10** from the blender **B**. In another embodiment, **FIG. 11** illustrates a releasable securing assembly **110** comprising the quick release pin **18**, hopper tongue **26**, locking tangs **78** (in place of the divider plate **28** and locking grooves **42** of releasable securing assembly **100**), and retaining brackets **68**.

Returning to **FIG. 5**, quick release pin **18** can be slidably engagable through both an aperture **11** in the bottom portion of removable hopper **10** and corresponding retaining brackets **68** when the hopper **10** is properly resting upon top plate **12**. Hopper tongue **26** extends from the bottom portion of the hopper **10** and is slidably engagable within a corresponding locking groove **42** in the divider plate **28**. When the removable hopper **10** is securely mounted to the top plate **12**, the quick release pin **18** provides a first securing subassembly with the hopper **10** (via the hopper aperture **11**) and the top plate **12** (via the retaining brackets **68**). The tongue **26** provides a second securing subassembly with the hopper **10** and the divider plate **28** (via locking groove **42**).

As shown in **FIG. 11**, quick release pin **18** can be slidably engagable through both the aperture **11** in the bottom portion of removable hopper **10** and corresponding retaining brackets **68** when the hopper **10** is properly resting upon top plate **12**. Hopper tongue **26** extends from the bottom portion of the hopper **10** and can be slidably engagable within a corresponding locking tang **78** extending from the top plate **12**. When the removable hopper **10** is securely mounted to the top plate **12**, the quick release pin **18** provides a first securing subassembly with the hopper **10** (via the hopper aperture **11**) and the top plate **12** (via the retaining brackets **68**). The tongue **26** provides a second securing subassembly with the hopper **10** and the top plate **12** (via locking tang **78**).

In operation, the removable hopper 10 can be released from the top plate 12 by first pulling the quick release pin 18 out of the retaining brackets 68 and the hopper aperture 11, and then sliding the tongue 26 out of the locking groove 42 in the divider plate 28. The hopper 10 then can be lifted free from the top plate 12. To replace the hopper 10, the hopper 10 is placed over the retaining brackets 68, slid forward until the tongue 26 slides into the locking groove 42 of the divider plate 28, and then the quick release pin 18 is placed through the aperture 11 in the hopper 10 that lines up with the retaining brackets 68. Other than the slight maneuvering by tilting or the like that may be necessary to slide the tongue 26 out of the locking groove 42 in the divider plate 28 (FIG. 5), or to slide the tongue 26 out of the locking tang 78 extending from the top plate 12 (FIG. 11), the present assembly enables the hopper to be simply and easily raised up vertically in place - there is no horizontal shifting of the hopper prior to lifting it off the blender.

The present invention does not incorporate a shoe element as required in prior art devices. As previously discussed, the Maguire device utilizes both a slide gate and shoe, wherein the slide gate remains with the blender upon hopper removal, and wherein there is space between the slide gate and the shoe. When the hopper and shoe are removed from the blender, residual material will remain behind, and sit on top of the slide gate, which residual material was located in the space between the shoe and slide gate before hopper removal. This amount of material must be cleaned out with the hopper removed, and only then can the new hopper be placed on the blender.

Unlike Maguire, since the slide gate 22 of the present invention is the hopper sealing mechanism, and is removed along with the hopper 10, there remains no residual material that must be cleaned out before the hopper can be replaced on the blender.

While the invention has been disclosed in its preferred forms, it will be apparent to those skilled in the art that many modifications, additions, and deletions can be made therein without departing from the spirit and scope of the invention and its equivalents, as set forth in the following claims.